

Enabling and Emerging Technologies for IT

A White Paper submitted to

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Introduction and Need:

Information Technology (IT) field can be roughly divided into two groups: 1) Core technology developers and 2) Users. The former group includes those who develop hardware, software, protocols and system designs that enable the current and future IT technologies. The latter group includes those who utilize the available technology to perform useful and innovative tasks that may not be possible otherwise.

Both these are important functions and need to be pursued under the current IT initiative. However, for a university whose goals include creation of new knowledge and advancing the boundaries of the existing knowledge, topics covered under Group 1 above are of greater significance in the long run.

This proposal addresses the sub-area of core technology that is necessary to design the hardware components that make possible the physical realization of any IT system. It is this technology that makes possible any IT system and is also responsible for the ultimate limits of the performance of the IT system in use whether involving computers or communication. For example, the fastest clocking speed permitted in a computer or the highest possible data transfer bit rate supported by a communication medium are limited by the technology in use. Advances in this material and device core technology area are the ones that will result in fundamental advances. Improvements in the other core technology areas such as software, coding, protocol or signal processing provide performance enhancement within the framework specified by the device and material technologies. The latter forms a skeleton on to which the others provide muscle. Advances in the device and material technology provide fundamental improvements in the technology by pushing the ultimate performance limits of IT system.

We define the core device and material technologies as the *enabling* technologies for IT. This technology is clearly multi-disciplinary and involves device physics, material science and technology of electronic, photonic and optical materials; novel device concepts, device design and device fabrication. LSU and indeed the state of Louisiana have been traditionally weak in this core technology area. It is our opinion that a major research university must have a presence in this area of IT at regional and national levels. This proposal addresses this shortcoming at LSU.

Goals

The main goal of this proposal is to build on existing diverse strength on this campus to a level that is visible and viable at the national scene in the core technology area of devices and materials for IT. Currently, the expertise in this area is spread out over several departments and is below a threshold to make significant impact either at the regional or the national level.

We call this area as *enabling* and *emerging* technologies for IT. The former pushes the state of the art of the existing technology through advances for example in the clocking speed of a computer or optical gain in a fiber optic channel. The latter corresponds to development of

entirely new technology that could replace or supersede the existing technology. This would be the case of a new type of transistor or circuits developed for example using spintronics or some other new technology that will replace the existing CMOS technology. This type of research is more futuristic but has many rewards and has high potential for putting us on the national map in a few years.

In order to fulfill the goals in this area, we request:

- Eight new faculty positions to augment the existing faculty strengths at LSU in the area of Enabling and Emerging Technologies for IT.
- Appropriate level of start-up funds for research equipment for new hires.
- Support for institutional infrastructure improvements in the area of devices and materials for IT to make LSU attractive for recruiting and retention of new faculty hires.

Current Situation

A variety of activities at LSU underway in several departments fall under the proposed umbrella of Enabling and Emerging technology. This includes Electronic Material and Device Laboratory in the Department of Electrical and Computer Engineering (ECE). Five faculty members are currently involved in certain aspects of device design, fabrication, circuit simulation and MEMS technology for IT. There are four faculty members in the Mechanical Engineering department working on microfabrication and MEMS with interest in MEMS sensors for large scale remote sensing of environment, health and other purposes. The importance of MEMS based sensor technology for future IT applications for medicine, defense, transportation and consumer products can not be over emphasized. There are at least two faculty members in the Chemical Engineering department working on materials for enabling technology for IT. There are at least three faculty members in Chemistry working on electronic materials for enabling technology. There is at least one faculty in Physics department working in the emerging technology area of spintronics.

In addition, CAMD provides limited infrastructure in microfabrication capability and provides surface and material characterization capability that are directly relevant to the proposed core technology area. A separate institutional infrastructure proposal has been submitted in the area of for enhancing the microfabrication capability at CAMD [1]. This enhancement will be of significant benefit for researchers in this group. The need for infrastructure improvement in the microfabrication area cannot be overstated. Improvements are necessary to recruit and retain good faculty members and graduate students. Traditionally, LSU has suffered and continues to suffer in recruitment and retention of good faculty in this area. For example, ECE department lost two active faculty members in microfabrication and MEMS area in the past four months.

Plan

Even though significant work in many different areas is underway, LSU lacks visibility and central focus due to 1) a lack of critical mass in defined objective areas and 2) deficiencies in infrastructure. Both these can be addressed by this new IT initiative.

We propose that the following steps be taken to crystallize our current research in the area of enabling and emerging technologies, to give it critical mass to conduct nationally visible research:

- Add three faculty positions in the area of electronic materials and devices
- Add two faculty positions in the area of emerging technologies (futurist technology beyond silicon)
- Add three positions in the area of photonic materials and devices

The positions may reside in one of several departments (ECE, Physics, Mechanical Engineering, CAMD, Chemical Engineering or Chemistry). It is imperative that appropriate startup funds are provided to the new faculty. In some cases these funds may be significant such as a MBE [2] growth system for photonic materials and devices. It is also strongly recommended that the status of the basic infrastructure in microfabrication be improved at CAMD for all researchers at LSU. This infrastructure is vital for all researchers and provides common fabrication tools that all researchers in this area need at one time or other. It is also essential in recruiting and retaining top-notch faculty and students.

This proposal also addresses the deficiency in electronic materials research cited by the AAAS committee of external reviewers [3] and addresses directly the thrust areas of ‘Micromanufacturing’, ‘Materials’ and ‘Information Technology’ in the state’s Vision 2020 Plan. It is also in concert with ‘Biomedical’ and ‘Environmental’ thrust areas of the Vision 2020 Plan.

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1. “Microfabrication, Materials and Device Technologies for IT,” submitted to LSU CAPITAL by CAMD and Department of Electrical & Computer Engineering for institutional infrastructure enhancement.
 2. MBE is an acronym for Molecular Beam Epitaxy.
 3. “A Review of the Potential for a Program in Materials Science and Engineering at LSU,” Report by the AAAS External Review Team, January, 2001.